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FLOCKS OF THE COMMON
DOMESTIC FOWL

A DISSERTATION SUBMITTED TO THE FACULTY OF THE
DIVISION OF THE BIOLOGICAL SCIENCES IN CANDIDACY
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF ZOÖLOGY
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SOCIAL DISCRIMINATION IN SMALL FLOCKS OF THE COMMON DOMESTIC FOWL¹

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The observations reported here were made concurrently with others, reported separately, in a study of the social organization of birds. The basic work of Schjelderup-Ebbe (1922) on the social hierarchy of chickens obviously suggests that these birds display recognition and discrimination of individuals in the flock to make a social order possible. Does discrimination extend beyond the individual to the point of social discrimination, i.e., is there a reaction to social position? Murchison (1935) developed a technique to study social discrimination. He studied the social hierarchy in *Gallus domesticus* from the viewpoint of social psychology in an effort to identify basic and simple social quanta, which he called social reflexes. "Social reflex No. 1" was measured in a "social reflex runway" in terms of the time and space in which the subjects moved toward each other. "Social reflex No. 2" was based on dominance, which was determined by the results of fights between each possible pair of males. Units of dominance were expressed in terms of the number of individuals each cockerel defeated in combat. "Social reflex No. 2" was not reported for the pullets used throughout the experiment. He found that "social reflex No. 2" may be determined best as a perfect linear function of "social reflex No. 1." "Social reflex No. 3," the sex reflex, was measured simply in terms of the number of treadings engaged in by each individual. Each individual, male and female, was tested in a "discrimination cage" for social discriminations with pairs of the same and opposite sex, and for sex discriminations with heterosexual pairs. Social discriminations by the males and the females, as groups, for pairs of males were related to dominance, and he concluded (1935b, p. 28) "that male discriminations for pairs of males are away from dominance, and that female discriminations for pairs of males are in the direction of dominance." Social discriminations by males and females, as groups, for pairs of females were compared with the number of times each of the pullets was trod, and his data show no keen discrimination by either the males or the females for pullets higher or lower in the number of times trod. The females, as a group, showed no marked sex discrimination, but when the discriminations to members of pairs containing males that failed to tread were excluded from the data, he found that the males received notably more discriminations than the females of the pairs. The males, as a group, showed a pronounced discrimination toward the female.

The standard method used in recent experiments to determine the social or-

¹ The author wishes to express his appreciation to Dr. W. C. Allee for making the arrangements for the pursuit of this study, and for the stimulating professional comments made during the course of this research.

ganization in birds is based on peck-rights or peck-dominance as described, among others, by Schjelderup-Ebbe (1922, 1925); Masure and Allee (1934); Allee, Collias and Lutherman (1939); Shoemaker (1939); and Bennett (1939). In chickens the peck-order is relatively fixed in adult birds. In the study reported here, social discriminations were observed in a discrimination pen and then related to the position in the peck-order and to the behavior in the pen.

MATERIAL AND METHOD

Two flocks of White Leghorn hens and cocks were used. They were housed in the poultry house at Whitman Laboratory in pens 14.5 x 4.5 x 8.0 feet high. During the early part of the experiment the males and females of each flock were in separate pens to determine their peck-orders, and the males were then placed singly for daily periods with the hens of their respective flocks to study the sexual behavior of the cocks and the hens without the influence of the male peck-order. After several weeks of observations all the cocks of each flock were placed with their female flockmates, and observations on the heterosexual behavior were continued. The data on the sexual behavior in the pen are reported separately. Social discriminations, which are the subject of this paper, and involved both males and females, were made during the interval when the cocks were continuously in the pen of the hens, i.e., when the social position of the cocks and of the hens could influence heterosexual discriminations. It should also be noted that all adult cocks dominate all the hens, i.e., peck-orders are essentially homosexual in chickens.

The social discrimination pen. This apparatus was built, as described by Murchison, on a cement floor in the greenhouse at Whitman Laboratory. The dimensions are given in figure 1. The floor plan of this pen formed an isosceles triangle with a release box at the truncated apex. Two wire cages were placed within, one along each side 11.5 feet from the release box, and 5.5 feet from the end of the discrimination pen. The sides and top of the frame were covered with cheesecloth, and the interior was illuminated by three 60 watt lamps. The release box, mounted on the door, was made of presswood and its inner side was raised, for releases, by pulling a cord that threaded through a pulley at the top of the door. A bird was placed in each cage and a third in the release box, the latter was then released on a median plane between the pair. After the discrimination the pair was reversed for a second discrimination to allow for probable directional effects. All possible pair combinations were used for each bird, male and female. Discriminations were recorded as to superior or inferior, male or female, and as to individual to individual for further analysis. A total of 5486 releases were made, of which 2485 or 45.2% resulted in non-discriminations. The peck-orders were based on a total of 9336 recorded pecks or threats; and 933 matings or treadings were observed. Of Murchison's 1380 releases only two were not recorded as discriminations, and the recorded treadings totaled 292.

The question arose as to when a bird had discriminated. The released bird may run directly to one cage and stand attentively; it may go slowly or stop part

way and then go directly to one or the other; it may remain at the center of the triangular pen for several minutes; it may remain at the release box or it may go straight down the median plane to the rear of the wire cages apparently paying no attention to either of the pair. When not discriminating the released bird may merely stand inattentively or it may preen or rest on the floor. A bird was not considered as having discriminated unless it paused within one foot of a wire cage. After discriminating the bird may stand for some time looking at the caged individual; may threaten the caged bird; may preen or rest; or after a pause proceed elsewhere or to the other of the pair; in the latter case the first discrimination was recorded. Many variations occurred. Internal stimuli may be apparent, such as the irritability prior to egg laying, hunger or thirst. An arbitrary time limit was set for the released bird to react, at the beginning it was five minutes and later reduced to two minutes. In a number of instances a non-discriminating bird was left undisturbed for ten or twenty minutes and even then no discriminatory reaction was given.

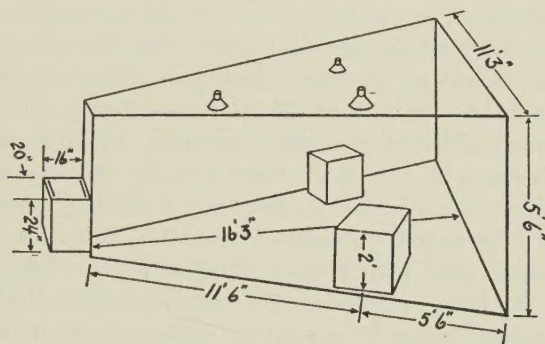


FIG. 1. DIAGRAM OF THE DISCRIMINATION PEN. DESCRIPTION GIVEN IN TEXT

A "social reflex runway" was not used since the social order was determined on the basis of pecks and threats delivered and received, and which were tabulated daily throughout the experiment. In the various tables the social order of the males (by Roman numerals) and the females (by letters) is indicated in the order given, beginning with the *alpha* bird. The data under (1) give the number of discriminations of each bird to the superior or inferior of the pair, and non-discriminations; that under (2) give the analysis for directional effects, which did not become apparent in any of the tests. The column headed "to same" indicates that the reversing of the pair resulted in no change in the second discrimination; a "split" indicates that the second discrimination was to the other of the pair. The column "single discriminations" gives the number of times that each bird discriminated only once for the two releases. In all columns the actual number of discriminations is given. The results of each flock are tabulated separately in each of the tables. The statistical significance (P) of the paired comparisons was obtained by Student's method (1925).

Discriminations may be influenced by several factors considered intrinsically

and extrinsically, i.e., the released bird may be influenced in its response by its individuality with regard to any of these factors or by the individuality of the caged birds as stimuli differing qualitatively in these factors. The simplest form of social discrimination would involve a bird of a given sex with pairs of the same sex, and may be influenced by social status and individuality. Testing a bird of one sex with pairs of the opposite sex, although it is also a social discrimination, introduces another factor, the relative sexuality of the subjects. The intensity or nature of the response may be influenced intrinsically by the relative libido of the reactor and extrinsically by the relative "sex appeal" or sexual attractiveness of the caged birds. The discriminations of heterosexual pairs of the sex discriminations may be expected to include the factors of social status, individuality, relative sexuality, with the addition of sex recognition. A breakdown of the data was made to consider these elements but the data on the bird-to-bird reactions are insufficient in several cases to merit a careful analysis.

Flock D. The hens of this flock were mature when received in October 1939. The cocks were obtained as newly hatched chicks in August 1939; they were reared with females of the same age, and removed to a pen by themselves about three weeks after treadings became numerous. Observations on social discriminations were made from June 28 to September 1, 1940. Straight-line peck-orders prevailed, although changes occurred in that of the cocks.

Flock F. Both sexes of this flock were sexually mature when received in February 1941; they were hatched in February 1940 and reared together after being brooded in homosexual groups. Cock VIII, however, although of approximately the same age, came from a different flock. Triangles occurred in the peck-order of the hens, YG pecked PB and GB pecked YB. The hierarchy of the males was straight-line; V became the *alpha* cock by defeating VI shortly after discrimination tests were begun. This flock was run in the social discrimination pen between April 12 and August 18, 1941.

For comparative purposes it should be stated here that Murchison's birds were raised as chicks in standard brooders and lived as a unit from the 16th week in a wire cage in the laboratory, Murchison (1935a). His observations on social discrimination were made when his cockerels and pullets were from 20 to 36 weeks old.

OBSERVATIONS

Social discriminations of males by males

The males of both flocks were run in the social discrimination pen at three different periods. With flock D, in period (A), table 1; the social order was changing; cock III lost position to IV (a cock excluded from these tables since he died during this test), and cock II was driven about the pen by I. Test (B) was made twenty days later when the new order appeared to be established, and (C) was run three months later when II and III were socially and sexually suppressed by I. The paired comparison for all three periods, grand totals of the columns "to superior" and "to inferior" for the D-cocks is statistically insig-

nificant (P equals 0.56). The P -values for the three periods are respectively 0.86; 0.55 and 0.60, and are statistically insignificant. In all three periods the dominant cock I reacted positively to the superior of the pairs, while the subdominant II reacted negatively to the superior. The subdominant III reacted negatively to the superior in (A) and (C). The general impression is given that dominance makes for a different type of discrimination from subordination.

TABLE 1
The social discriminations of males by males

PERIODS	PECK-ORDER OF DISCRIMINATORS	1			2			
		To superior	To inferior	Non-discrimination	Both releases to same		Split	Single discriminations
					Superior	Inferior		
Flock D								
A.....	I	15	2	1	12	0	4	1
	II	1	17	0	0	16	2	0
	III	0	3	15	0	2	0	1
Total.....		16	22	16	12	18	6	2
B.....	I	10	7	1	4	0	12	1
	II	2	11	5	0	8	2	3
	III	6	7	5	0	0	12	1
Total.....		18	25	11	4	8	26	5
C.....	I	11	4	3	6	0	8	1
	II	4	12	2	0	8	6	2
	III	3	10	5	0	6	4	3
Total.....		18	26	10	6	14	18	6
Grand total.....		52	73	37	22	40	50	13
Flock F								
	V	22	23	9	6	8	24	7
	VI	12	7	35	8	2	6	3
	VII	13	8	33	8	2	4	7
	VIII	24	4	26	10	2	2	14
Total „.....		71	42	103	32	14	36	31

The bird-to-bird discriminations, table 2, flock D, throw some light on these reactions when interpreted by the interactions observed in the home pen. I went more frequently to II than to III, which may reflect the antagonism observed in the pen which I showed toward II; and reciprocally II avoided I, which may account for the nearly complete lack of his discriminations for I. To his inferior, II showed a definite discrimination. During periods (A) and (B) III spent most of his time on the roost, and had little contact with the other cocks,

and during this time he failed to discriminate positively to either of the other two cocks. II was driven to the roost consistently by I and by (C) became conditioned to spend more time there in company with III, with the result that II became tolerant of III and this change may account for III's more frequent discriminations to II in (C).

With the cocks of flock F there was no very marked difference between the three periods, although they were tested under different social situations, and

TABLE 2

The bird-to-bird discriminations occurring during the social discriminations of males by males

DISCRIMINATOR	PERIOD	FLOCK D			
		To I	To II	To III	Totals
I	A		10	6	16
	B		6	4	10
	C		11	4	15
Total.....			27	14	41
II	A	0		7	7
	B	0		8	8
	C	4		12	16
Total.....		4		27	31
III	A	0	0		0
	B	4	4		8
	C	3	10		13
Total.....		7	14		21
Grand total.....		11	41	41	93

Flock F

	To V	To VI	To VII	To VIII	Totals	
V		15	14	16	45	
VI	10		5	4	19	
VII	2	14		5	21	
VIII	11	16	1		28	
Total.....	23	45	20	25		113

the data are given as a unit. During the first period VI lost position to V who became the *alpha* cock; the second run was made when the order appeared to be established and the last when all the males had been in the pen of the hens of their flock for 46 days. The comparison of the columns "to superior" and "to inferior" for flock F is statistically insignificant (P equals 0.08). For the three periods P equals 0.09; 0.43 and 0.09 respectively, i.e., insignificant. With the males of both flocks, Murchison's generalization that male discriminations for pairs of males is away from dominance is not substantiated. And as with the

D-cocks it also appears that dominance makes for a different type of discrimination, although it is here somewhat masked by a peculiarity of VI. In table 2, flock F, it will be noted that the *alpha* male V went about equally to the other three males and that he had the fewest non-discriminations (table 1). VI went more times to V, and most of these occurred in the first period when VI was still superior to V. Most of VII's discriminations for VI occurred during the more unstable first period when he frequently threatened VI. VIII was tolerated by V throughout, which may account for the large number of his discriminations for V, while an antipathy occurred between VIII and VII, as is shown by the single discrimination for VII. VIII frequently threatened VI during the first and second periods, which is reflected in his larger number of discriminations to VI. The more numerous discriminations by all of the cocks to VI was probably due to the fact that VI lacked social aggressiveness, although he was an able fighter when forced to fight.

The value of the table on bird-to-bird discriminations lies in the evidence that individual differences influence discriminations, and that marked changes in the social activity in the pen merit consideration in the analysis of the data.

Social discriminations of females by females

The paired comparison for flock D of the columns "to superior" and "to inferior", as summarized in table 3, is statistically insignificant (P equals 0.21). Most of the larger deviations can be accounted for. Table 4, flock D, shows the number of times that each hen went to each of the hens, and the number of times that it went to the other of the pair. In general, the distribution of the discriminations appears to be comparatively uniform. In the pen BB was tolerated by GY, and in the discrimination pen, BB went twice as often to GY as to the other members of the pairs containing GY. RY went twice as often to GY and one and one-third times as often to BB as to the other members of the respective pairs. In the pen YY showed an antagonism toward RW; she went seven times as often to RW, the only bird pecked by YY. The asterisks indicate cases in which a bird went more frequently to a hen superior to itself, a situation that would not be evident in the pen where avoiding reactions appear to be the rule for inferiors in pair-contacts when the birds are active; and which does not appear from the analysis of the preceding table. This analysis suggests that former pair-contact experience operates as a factor in discrimination, and that a discriminator may react differently to its superiors when they are caged.

With flock F the paired comparison of the columns "to superior" and "to inferior" of Table 3 is barely significant statistically (P equals 0.05). No satisfactory explanation can be offered for this difference in statistical significance between these two flocks. Antipathies occurred in flock F as in flock D but they were not very pronounced nor did they persist. To the observer, this flock of hens appeared to be more passive socially. GB would not discriminate, she was ill toward the end of this test and died a few days later. In the pen she was quite active but she assumed a negative or "fearful" attitude in the discrimination pen when handled, which suggested a conditioning effect.

In the distribution of bird-to-bird discriminations, table 4, flock F, the numbers are too small to warrant a breakdown such as was made for the D-hens. The relatively uniform number of discriminations each bird made to each of its flockmates does not suggest the significance of a generalization that female discriminations for pairs of females are away from dominance, as Table 3 indicates statistically for the F-females. Nor do the total discriminations received by each bird suggest that such is the case. Since the total number of non-dis-

TABLE 3
The social discriminations of females by females

PECK-ORDER OF DISCRIMINATORS	1			2			
	To superior	To inferior	Non-discrim- inations	Both releases to same		Split	Single dis- criminations
				Superior	Inferior		
Flock D							
GY	30	28	32	14	16	14	14
BB	41	23	26	24	10	22	8
GG	33	36	21	12	14	32	11
BR	37	39	14	20	24	24	8
RY	34	17	39	16	8	14	13
YY	27	35	28	16	26	10	10
RW	41	23	26	22	10	22	10
Total.....	243	201	186	124	108	138	74
Flock F							
WG	13	23	72	0	8	12	16
RG	28	36	44	6	4	36	18
PB	38	34	36	16	18	22	16
YB	22	32	54	6	12	16	20
RB	16	12	80	6	4	8	10
*YG	26	48	34	6	18	34	16
*GB	0	0	100	0	0	0	0
YR	15	47	42	6	30	10	16
WR	46	57	3	24	34	42	3
Total.....	204	289	465	70	128	180	115

* YG pecks PB, and GB pecks YB.

criminations is high (48.5% of the releases) and since the total discriminations made by each bird, when GB is excluded, vary from 28 to 103, and since individual differences appear to play a part in the other tests, it is probable that the latter may be an unanalyzable factor in operation in this test with flock F.

Social discriminations of females by males

Hen YY of flock D was not included in table 5 as at this point in the experiment she received a pellet of testosterone and was not normal in her behavior.

The results are statistically insignificant (P equals 0.66). The reactions in terms of individuals in Table 6 show no significant individual deviations. The males did not appear to discriminate much between the females, although cocks I and II went less to RW, and III went less to RY and more to GG. The small

TABLE 4

The bird-to-bird discriminations occurring during the social discriminations of females by females

Flock D

DISCRIMINATOR	GY			BB			GG			BR			RY			YY			RW		
	To GY	To other of pair	No discrim.	To BB	To other of pair	No discrim.	To GG	To other of pair	No discrim.	To BR	To other of pair	No discrim.	To RY	To other of pair	No discrim.	To YY	To other of pair	No discrim.	To RW	To other of pair	No discrim.
GY				8	9	13	7	14	9	10	12	8	14	4	12	11	6	13	8	13	9
BB	*12	6	12				11	14	5	13	12	5	15	6	9	10	10	10	3	16	11
GG	9	15	6	8	18	4				17	6	7	14	10	6	13	8	9	8	12	10
BR	11	12	7	10	15	5	*17	11	2				11	15	4	18	10	2	9	13	8
RY	*10	5	15	*12	9	9	4	9	17	9	10	11				10	6	14	6	12	12
YY	*13	5	12	7	19	4	11	12	7	6	12	12	4	11	15				21	3	6
RW	10	10	10	*17	8	5	10	11	9	*13	9	8	*13	9	8	1	17	12			
Total.....	65	53	62	62	78	40	60	71	49	68	61	51	71	55	54	63	57	60	55	69	56

Flock F

	TO WG	TO RG	TO PB	TO YB	TO RB	TO YG	TO GB	TO YR	TO WR	TOTAL
WG		2	5	4	5	4	5	6	5	36
RG	9		12	8	4	7	6	8	10	64
PB	7	14		9	5	8	11	9	9	72
YB	4	8	5		8	8	8	4	9	54
RB	5	5	7	2		3	2	3	1	28
*YG	8	8	13	6	10		8	9	12	74
*GB	0	0	0	0	0	0		0	0	0
YR	3	3	8	5	10	11	8		14	62
WR	9	14	17	13	12	12	14	12		103
Total.....	45	54	67	47	54	53	62	51	60	493

* Flock D; discriminator went more frequently to a hen superior to itself. *Flock F; YG pecks PB, and GB pecks YB.

number of cases recorded does not warrant any conclusion other than that some individual differences occur.

With flock F the paired comparison of the columns "to superior" and "to inferior" of table 5 is statistically insignificant (P equals 0.15). As with flock D the males do not appear to discriminate between the social positions of the hens. But there is some indication in table 6 that the males may react dif-

ferently to different hens (from the viewpoint of the hens), thus YG received fewer positive discriminations by all the cocks. Each of the males discrimi-

TABLE 5
The social discriminations of females by males

PECK-ORDER OF DISCRIMINATORS	1			2			
	To superior	To inferior	Non-discriminations	Both releases to same		Split	Single discriminations
				Superior	Inferior		
Flock D							
I	16	24	50	4	12	8	16
II	26	17	47	10	0	18	15
III	47	40	3	28	20	36	3
Total.....	89	81	100	42	32	62	34
Flock F							
V	44	46	22	26	26	26	12
VI	21	25	66	12	12	8	14
VII	12	17	83	6	6	4	13
VIII	29	48	35	2	16	44	15
Total.....	106	136	206	46	60	82	54

TABLE 6
The bird-to-bird discriminations occurring during the social discriminations of females by males

Flock D									
DISCRIMINATOR	TO GY	TO BB	TO GG	TO BR	TO RY	TO RW	TOTAL		
I	6	11	10	6	14	3	50		
II	6	9	11	9	9	1	45		
III	12	11	26	18	8	13	88		
Total.....	24	31	47	33	31	17	183		
Flock F									
DISCRIMINATOR	TO WG	TO RG	TO PB	TO YB	TO RB	TO YG	TO YR	TO WR	TOTAL
V	15	6	17	7	14	6	16	9	90
VI	6	12	6	8	1	3	2	8	46
VII	7	5	2	7	1	2	2	3	29
VIII	9	15	10	8	7	3	10	15	77
Total....	37	38	35	30	23	14	30	35	242

nated differently to some of the hens. This influence of individual differences was also apparent in the study of sexual behavior in the pen, where the frequency of treadings and courtings showed no relationship to social position.

Social discriminations of males by females

This test, with flock D, table 7, is in agreement with Murchison's conclusion that female discriminations for pairs of males are in the direction of dominance. The results are statistically significant (P equals 0.02). The bird-to-bird reactions of table 8 indicate a rather uniform distribution of discriminations. The trend here, however, may be due to individual differences in the behavior patterns of the males rather than to the social position of the males. The paired comparison of columns I and II is insignificant (P equals 0.22), and that of columns I and III approaches significance (P equals 0.06). Prior to the time

TABLE 7
The social discriminations of males by females

PECK-ORDER OF DISCRIMINATORS	1			2			
	To superior	To inferior	Non-discrim- inations	Both releases to same		Split	Single dis- criminations
				Superior	Inferior		
Flock D							
GY	9	6	3	2	0	12	1
BB	12	4	2	8	0	8	0
GG	8	8	2	0	2	12	2
BR	9	6	3	4	2	6	3
RY	7	3	8	4	0	4	2
RW	8	6	4	4	2	8	0
Total.....	53	33	22	22	6	50	8
Flock F							
WG	6	2	40	0	0	2	6
RG	28	20	0	14	6	28	0
PB	14	19	15	4	12	10	7
YB	12	10	26	6	2	2	12
RB	1	1	46	0	0	2	0
*YG	9	6	33	2	0	8	5
YR	6	9	33	0	2	2	11
WR	25	20	3	10	6	26	3
Total.....	101	87	196	36	28	80	44

* YG pecks PB.

of this test, III spent nearly all of his time on the roost and about three days before these observations were made he began to come to the floor to feed. It may be that he was socially estranged from the hens, which may account for the significant difference between I and III. II on the other hand, although exhibiting a peculiar behavior at the time, spent much more time on the floor. I showed no peculiarities in sex behavior and trod freely.

The fact that the social discrimination of males by females is significant does not necessarily imply that the hens showed a "preference" for I as the dominant

male, as their reactions may have been negative discriminations of II and III and positive only to I. The remarks under sex discriminations of heterosexual pairs by females seems to indicate that such is the case. Schjelderup-Ebbe (1922) claims that the hens show no "preference" for any male. The difference found here is evidently due to negative reactions to certain cocks. When the cocks were singly in the pen of the hens there was a predominance of negative reactions on the part of the hens to cock II.

With flock F, table 7, this test was statistically insignificant (P equals 0.17). In flock D it was found to be significant, although questioned on the basis of the

TABLE 8

The bird-to-bird discriminations occurring during the social discriminations of males and females

Flock D

DISCRIMINATOR	TO I	TO II	TO III	TOTAL
GY	6	4	5	15
BB	9	3	4	16
GG	5	6	5	16
BR	6	5	4	15
RY	6	1	3	10
RW	4	6	4	14
Total.....	36	25	25	86

Flock F

DISCRIMINATOR	TO V	TO VI	TO VII	TO VIII	TOTAL
WG	3	2	2	1	8
RG	15	12	9	12	48
PB	10	4	9	10	33
YB	5	8	5	4	22
RB	0	0	1	1	2
YG	5	3	4	3	15
YR	4	4	3	4	15
WR	12	12	13	8	45
Total.....	54	45	46	43	188

observations of behavior in the pen and by an analysis of the bird-to-bird data. Applying the same statistical comparisons in table 8 for flock F, the following P -values are found; for columns V and VI, P equals 0.26; for V and VII, P equals 0.23; and for V and VIII, P equals 0.055; the last approaches significance. All but VIII were quite similar in their behavior toward the hens, but VIII was erratic and in the home pen received considerably more avoiding reactions than the other roosters. The data suggest that individual differences in the behavior of the cocks toward the hens is a factor, but since peculiarity in behavior involved only one male in this test with the F-cocks it may not have become statistically evident for the group as with the D-cocks with which (as discussed above and

under sex discriminations by females) the *alpha* cock I was the only male that trod when this test was made.

Sex discriminations of heterosexual pairs by males

As one would expect, the sex discriminations by the D-males were definitely toward the female. The "to male" and "to female" columns of table 9, flock D, when compared statistically are significant (P equals 0.02). These results are also in agreement with Murchison. The breakdown given in table 10 shows a comparatively uniform distribution of discriminations among the females. The larger number of non-discriminations on the part of cock II may be the result of a conditioning effect: briefly, he was attacked by I, in the pen, whenever

TABLE 9
The sex discriminations of heterosexual pairs by males

PECK-ORDER OF DISCRIMINATORS	1			2			
	To male	To female	Non-discrim- inations	Both releases to same		Split	Single dis- criminations
				Male	Female		
Flock D							
I	11	69	4	2	56	16	6
II	3	17	64	2	6	2	10
III	7	67	10	0	52	12	10
IV	10	63	11	2	52	14	5
Total.....	31	216	89	6	166	44	31
Flock F							
V	23	32	41	10	12	12	21
VI	8	2	86	2	0	2	6
VII	23	7	66	14	2	2	12
VIII	8	42	46	0	18	8	24
Total.....	62	83	239	26	32	24	63

he approached a hen. A comparison of table 10 with 6 shows no striking difference in the discriminations by the D-males to each of the females. Based upon the results of the discrimination pen there is no indication of a "favorite" hen for any of the males. Skard (1936) is of the opinion that "each male has his favorite, but we can not give any reason for his choice." Heuser (1916) concludes that "favoritism on both the part of the male and the female is shown to a greater or less degree." He quotes from Wilkins (1915), "As regards preferential mating it would appear that no such thing exists. They are both heterogeneous in mating and show no preference for any one particular bird of the opposite sex." Murchison (1935c, p. 100) states, "The greater total of treadings which she (the favorite) receives is therefore a matter of simple arithmetic and not an indication of preference on the part of the rooster." The results discussed here conform to the latter view.

Unlike with the D-cocks the results with the F-cocks are statistically insignificant (P equals 0.65). One may be able to account for this difference by an examination of the bird-to-bird discriminations. Cocks VI and VII displayed less libido than V and VIII, as is suggested by the smaller number of discriminations (tables 5 and 9). This test was made when all of the cocks were in the pen of the females for about two weeks and at this time there was an increase in the interaction between the roosters. The *omega* cock VIII discriminated definitely more frequently in favor of the hens and not at all to VII who showed an antipathy toward him. The *alpha* V discriminated more frequently to the hens but his high number to VI reflects his effort in the pen to keep the latter in subjection. And VII with low libido went definitely more times to VI whom he threatened

TABLE 10

The bird-to-bird discriminations occurring during the sex discriminations of heterosexual pairs by males

Flock D

DISCRIMINATOR	TO GY	TO BB	TO GG	TO BR	TO RY	TO YY	TO RW	TOTAL
I	12	11	8	9	12	9	8	69
II	4	0	4	1	5	1	2	17
IV	11	11	9	9	9	9	9	67
III	9	11	10	9	8	10	6	63
Total.....	36	33	31	28	34	29	25	216

Flock F

DISCRIMINATOR	TO WG	TO RG	TO PB	TO YB	TO RB	TO YG	TO YR	TO WR	FE-MALE TOTAL	TO V	TO VI	TO VII	TO VIII	MALE TOTAL
V	9	4	6	4	1	1	2	5	32		12	8	3	23
VI	0	0	0	0	1	0	1	0	2	7		0	1	8
VIII	1	2	0	1	1	2	0	0	7	6	17		0	23
VII	8	7	7	5	2	4	3	6	42	4	4	0		8
Total....	18	13	13	10	5	7	6	11	83	17	33	8	4	62

occasionally in the pen. These pair-reactions of the males appear to have suppressed an expected tendency of the males to discriminate in favor of the hens, especially in those with less libido.

Sex discriminations of heterosexual pairs by females

The paired comparison of the "to male" and "to female" columns of table 11, flock D, is statistically insignificant (P equals 0.24), which means that these females did not distinguish between the sexes. However, in the pen the hens squatted for the cocks but not for the hens, which indicates that sex discriminations did occur. This discrepancy suggests that in the discrimination pen some other factor may have been in operation to obscure the sex discrimination. An

analysis of the bird-to-bird discriminations in table 12 gives evidence that such was the case. If we compare the discriminations which I (with the most discriminations) received with those of cocks II and III; and also compare the

TABLE 11
The sex discriminations of heterosexual pairs by females

PECK-ORDER OF DISCRIMINATORS	1			2			
	To male	To female	Non-discrim- ination	Both releases to same		Split	Single dis- criminations
				Male	Female		
Flock D							
GY	12	22	74	8	4	12	10
BB	43	41	24	16	12	40	16
GG	42	45	21	18	20	30	19
BR	47	27	34	22	12	18	22
RY	18	13	77	8	4	4	15
YY	28	16	64	18	12	6	8
RW	28	21	59	10	4	12	23
Total.....	218	185	353	100	68	122	113
Flock F							
WG	15	11	70	2	2	8	14
PB	21	17	58	6	4	18	10
YB	15	24	57	2	6	10	21
RB	0	0	96	0	0	0	0
*YG	13	4	79	4	0	2	11
YR	16	14	66	4	0	16	10
WR	47	49	0	28	18	50	0
Total.....	127	119	426	46	30	104	66

* YG pecks PB.

discriminations each cock received with those to the females paired with him, one obtains the following P-values:

Columns 1 and 2, P equals 0.01, highly significant
 Columns 1 and 3, P equals 0.01, highly significant
 Columns 1 and 4, P equals 0.01, highly significant
 Columns 2 and 5, P equals 0.61, insignificant
 Columns 3 and 6, P equals 0.16, insignificant

These results are to be interpreted that the females, as a group, discriminated in favor of I more frequently than to the other males or than to the females paired with I; but with cocks II and III the females went to the females of the heterosexual pairs as readily as to either of these males. We might also consider that since the hens are not sexually aggressive that the sex discrimination may have been obscured by their discrimination of the cocks according to the behavior pattern of the latter.

No very marked discrimination between the individual cocks by the hens occurred when the social discriminations of the cocks by the hens (table 8, flock D) were made. This change in the reactions to the individual cocks may be explained by observations in the pen. When this sex discrimination test was run the interaction between the cocks was intense. The truly dominant cock would drive II about the pen whenever II ventured forth, and as a result of this interaction the hens would make a wild dash for any perch. III avoided I by remaining on the roost. The intensity of I's reactions to II and III caused these

TABLE 12

The bird-to-bird discriminations of males by females occurring during the sex discriminations by females

Flock D

DISCRIMINATOR	NUMBER OF TIMES TO EACH MALE			NUMBER OF TIMES TO FEMALE PAIRED WITH		
	1 I	2 II	3 III	4 I	5 II	6 III
GY	7	3	2	8	7	7
BB	22	7	14	11	14	16
GG	16	11	15	16	18	11
BR	18	17	12	9	5	13
RY	17	0	1	5	5	3
YY	22	4	2	6	3	7
RW	15	7	6	7	6	8
Total.....	117	49	52	62	58	65

Flock F

	1 V	2 VI	3 VII	4 VIII	5 V	6 VI	7 VII	8 VIII
WG	6	6	1	2	3	2	2	4
PB	4	8	6	3	6	2	5	4
YB	3	9	3	0	7	8	6	3
RB	0	0	0	0	0	0	0	0
YG	4	5	4	0	2	2	0	0
YR	3	5	4	4	5	4	1	4
WR	11	14	12	10	13	10	12	14
Total.....	31	47	30	19	36	28	26	29

cocks to cease to tread. The test of the social discriminations of pairs of males by the females was made about one month later when the male interaction became less intense. II and III were tolerated to some extent by I, as they learned to ignore the hens, and the females showed less pronounced avoiding reactions.

Murchison (1935c, p. 80) had a similar condition. Three of his six cocks did not tread, which he suspected "may be the biological result of the crossbreeding of which these roosters are the product." His totals for discriminations of

heterosexual pairs by pullets were 139 to the males and 101 to the females, but when he excluded the figures for the non-treading males the ratios became 78 to 42 respectively. Since his six roosters and five pullets were housed together in a wire cage in the laboratory, one may assume that a similar form of conditioning may have occurred. II and III's behavior became typically sexless and is discussed in a separate report.

The paired comparison of the "to male" and "to female" columns for flock F, table 11, is statistically insignificant (P equals 0.63). These hens also appear to react to the cocks according to the behavior patterns of the latter and thereby obscure a possible sex discrimination. An analysis of the discriminations by the hens for each cock and to the hens paired with him substantiates the results with flock D. The paired comparisons of the columns of table 12, flock F, have the following P -values:

- Columns 2 and 1, P equals 0.03, significant
- Columns 2 and 3, P equals 0.02, significant
- Columns 2 and 4, P equals 0.01, highly significant
- Columns 1 and 5, P equals 0.25, insignificant
- Columns 2 and 6, P equals 0.01, highly significant
- Columns 3 and 7, P equals 0.57, insignificant
- Columns 4 and 8, P equals 0.06, approaches significance

The interpretation is that the hens as a group discriminated more frequently to VI than to any of the other cocks, and more frequently to VI than to the hens paired with him. With V and VII they went to the hens paired with them as readily as to these cocks, while with VIII they went to the hens paired with him more frequently than to him. These reactions are in agreement with observations in the pen. When this test was started all of the males had been in the pen of the hens for 32 days, and the nature of the interaction of the cocks as a result of the influence of the male peck-order was becoming relatively stabilized. VI was the most gentle with the hens, and VIII was erratic and even pecked the hens, and V and VII graded between them but closer to VI. This behavior is reflected in the results given here. The individuality of the cocks and not their social position determined the reactions of the hens toward them. In flock D the *alpha* cock I received the most discriminations, but in flock F the "favored" cock was second in social position indicating that the most acceptable cock is not necessarily the dominant cock.

DISCUSSION

Although some facts are quite evident from this study, the data gained from the discrimination pen require some careful consideration. With flock D the non-discriminations were 35.0% of the releases, and with flock F were 53.4%. These remain undetermined as either positive or negative reactions to either external or internal stimuli. Some birds discriminated quite freely while others discriminated only occasionally. GB and RB of flock F refused completely to leave the release box during some of the tests, even when left undisturbed for periods of from five to ten minutes; although there was nothing about their be-

havior in the pen to suggest the cause. It may be that in these extreme cases these birds reacted negatively to the discrimination pen. Peculiar reactions occurred occasionally, e.g., a cock or hen would at times fly to the top of one of the square cages and look up at the lamps overhead, and would be inclined to repeat this procedure during that day or thereafter, displaying a reaction to something in the environment. The discrimination pen technique assumes that the discriminations are positive in nature but the analysis of some of the data shows evidences of the effects of negative discriminations. This technique also assumes that the caged birds will serve as strong stimuli to which the released bird will react. What known factor is there, apart from sex, that attracts one bird to another? There may be a number of factors involved. In the pen they may wander or stand about individually. It was observed in the discrimination pen that when a caged cock gave the food-call that a hen was apt to go to him;

TABLE 13

The relation of general pen activity of each bird to the total number of times it discriminated, flock F

FEMALES				MALES			
Peck-order	Activity rating	Total number of discriminations	Discrimination rating	Peck-order	Activity rating	Total number of discriminations	Discrimination rating
WG	4	70	6	V	1	189	1
PB	3	143	2	VI	4	75	4
YB	2	115	3	VII	3	80	3
RB	6	30	7	VIII	2	155	2
YG	5	106	5				
YR	7	107	4				
RW	1	244	1				
Total.....		815				499	

or if a caged bird pecked on the bare floor as though feeding, the released bird was likely to discriminate to it.

The birds vary in their general activity, and from the descriptive remarks on individuality in the report on sex behavior one may rate them on this basis; when this order is compared with the total number of discriminations each bird made, one finds a direct relation in the males of flock F and a close relation in the females of this flock, table 13. The analysis may suggest a factor to account, in part, for the large number of non-discriminations. Murchison, who reported only two non-discriminations, used pullets and cockerels which are more active at that age. However, the subjective rating of general pen activity showed no relation to the number of times a bird received discriminations.

There is also evidence that to cage a bird alters its behavior as well as that of the free-birds toward the caged individual. When caged, the cocks did not wing-flutter to the hens that came to their cages; this was also noted when males were caged in the pen of the hens. Three of the D-hens wing-fluttered

nine times to caged birds, males or females, which with the exception of GG, did not show such behavior in the home pen. After YY of flock D received a pellet of testosterone her changed behavior was made evident in her discrimination pen behavior long before it appeared in the home pen; she would threaten and fight cocks II and III when these were caged but not when they were free with her in the home pen or in the discrimination pen. In the home pen a bird would usually avoid one superior to itself, when the birds were active, but in the discrimination pen they frequently discriminated to their superiors.

After due consideration of some vague factors and the method used in this experiment, there are certain facts that may be deducted from the observations. These birds, male and female, did not discriminate to social position, as such. In all of the tests it appeared that individual differences influenced discriminations, which indicates action and reaction according to individuality and to former pair-contact experiences, not all of which are summarized in a bare peck-order list. The males of flock D showed a definite sex discrimination; they reacted positively to the hen in a heterosexual pair. With the F-males it appeared that a tendency toward a definite sex discrimination was obscured by a more or less pronounced male pair-reaction which occurred at the time the test was made. The data give no indication of marked deviations by the cocks for any individual hen, i.e., a "favorite", while the hens showed no significant sex discrimination although the data show a marked deviation for a certain rooster. The cock receiving the most positive discriminations by the females was the *alpha* male in flock D and in flock F was second in the social order, which shows that the rooster which appeared to be most acceptable to the hens is not necessarily the *alpha* cock. It was suggested that the discrimination between the cocks by the hens was related to the behavior patterns of the males toward the females. This summary implies that the males discriminate positively to all the hens and negatively to certain individual cocks, while the females are neutral in female discriminations and positive toward a certain rooster. To state it another way, the aggressive cocks pursue any hen while the hens, more passive than the cocks, determine by means of either positive or negative reactions which rooster may be most successful. The interaction between the males may limit the opportunity of a cock to offer his attentions to the hens. This conclusion is in agreement with the observations on sexual behavior in the home pens, which, as has been stated, will be reported elsewhere in some detail.

Mr. Harry M. Smith, in connection with a course in Animal Behavior, worked independently with flock D during the months following the close of the tests given here for that flock. He tested the social discriminations of males and females for pairs of males, and of females for female pairs, and obtained results which substantiate the respective tests reported here.

An attempt was made to compare Murchison's data after making certain assumptions. Since the outcome of initial pair-contacts usually determine dominance relations in a flock and since "social reflex No. 2" was based on the number of individuals each cock defeated in combat, one may assume that "social reflex No. 2" reflects the peck-order of the males. And since Murchison found

a linear relationship between "social reflex No. 2" and "social reflex No. 1", one may also assume a peck-order for the pullets from the "social reflex runway" data. When Murchison's data are tabulated according to the inferred peck-orders for the cocks and pullets, and analyzed as to bird-to-bird discriminations, comparisons can be made with the respective tests of this report. However, information on individuality and pen behavior was not given in Murchison's data.

In the social discriminations of pairs of males by males Murchison found that male discriminations were away from dominance. The bird-to-bird discriminations, taken from his data, showed that the cockerels in the first and second position received 17 and 40 discriminations respectively, while the others received from 64 to 83 each, which indicates that the *alpha* and *beta* individuals were avoided. The social order changed during this test, which suggests pronounced pair-reactions in the home pen.

It was found in our work that dominance makes for a different type of discrimination and that marked pair activity was reflected in the discrimination pen by a decrease in discriminations to the superior of the pair. From this comparison one might conclude that Murchison's generalization for the males may hold for cockerels in small pens during the period in which the social order is in the process of formation. Murchison's conclusion that female discriminations for pairs of males is in the direction of dominance held for our D-females but not for the F-females; the difference was explained by differences in the behavior of the individual males toward the females, which was more pronounced when the male pair-reactions became intense and was also reflected in a decrease in mating success of the frustrated males.

Murchison made the test of social discrimination of male pairs by the females before the male hierarchy became straight-line and the bird-to-bird discriminations show that the females discriminated more times to the three males that trod (58 to 72) than to those that did not (30 to 41). Since his two top cocks trod most, one might expect that the element of male sex behavior was interpreted as though it were an expression of dominance. The social discriminations of female pairs by Murchison's males and females show a rather uniform distribution as to dominance and as to bird-to-bird discriminations, as with our flocks D and F.

In the sex discriminations the Murchison males that trod went to the female of the pair in every case while two of those that failed to tread went equally or nearly equally to either sex and one went about two times as frequently to the female. This test was made before the social order of the males became straight-line although the position of the *alpha* and *beta* cocks (both of which trod) was established. In our flock D this test was significant but not in flock F, and the difference was explained on the basis of the intensity of male pair-reactions in the home pen. It appears that a definite sex discrimination by males may be modified by the intensity of the pair-reactions of the males; in Murchison's data the males that did not tread were in the portion of the hierarchy that was not established. His rooster W trod and became the *omega* male, and there is

some evidence in the data that he was tolerated by the *beta* male; this appears to present a case comparable with IV of our flock D who was tolerated by the truly superior and trod freely. The sex discriminations by Murchison's females show a situation comparable with that found in flocks D and F, i.e., the females, as a group, went more frequently to the males that trod than to the hens paired with them, and went about equally to the males and the females of the pairs containing cocks that did not tread.

These comparisons are interesting since they suggest an agreement of the data of this report with those of Murchison's. The divergence of the two interpretations is apparently a result of (a) the social order of Murchison's group of males was in an unstable phase during his experiments on social discrimination, and (b) to the different viewpoints in the analysis of the data.

SUMMARY

Based on the reactions in small homo- and heterosexual flocks of White Leghorns in a discrimination pen, and when related to their behavior in relatively small pens, the following generalizations were deduced.

1. Neither cocks nor hens, as a group, discriminate to the social position, per se, of individual cocks or hens.

2. A statistically significant social discrimination of cocks by hens may be as much a matter of negative reactions to one cock as of positive reactions to the other.

3. The cocks of one flock, as a group, showed a statistically significant sex discrimination, but in the second flock this tendency appeared to be masked by an increase in the intensity of male pair-reactions which occurred in the home pen at the time this test was made.

4. The hens, as a group, showed no statistically significant sex discrimination, but the data indicate a marked deviation for a certain rooster, which was related to differences in the behavior of the cocks toward the hens.

5. The discrimination pen technique did not analyze all of the factors that make for, or influence, discriminations; and it was shown that to cage a bird altered its own behavior as well as that of the free-bird toward it.

6. Discriminations were notably influenced by individual differences which indicated that the birds acted and reacted according to individuality and to former pair-contact experiences.

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